Thermal dilation monitoring of single and double scatterers based on compressive sensing

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In this paper, we explore the temperature-induced dilation surveillance of buildings by virtue of recently proposed 5-D SAR imaging approach. 5-D SAR imaging, as an extension of differential SAR tomography, can monitor the subtle motion caused by thermal change and hence eliminate misinterpretation of elevation and linear velocity due to model inadequacy in 3-D and 4-D SAR as well as provide more details of the illuminated objects. Thanks to higher sensitivity to deformation brought by high frequency constellations TerraSAR-X and TanDEM-X, detection of minute change becomes feasible. Nevertheless, most current literatures regarding to 5-D SAR make their concern only on the single scatterer detection, besides, tomographic supperresolution has also not been achieved. In our experiment, TSX and TDX datasets are jointly used to reconstruct tomography. Firstly, preprocessing manipulations including amplitude calibration and phase compensation is implemented, therein, two key procedures should be pointed that network-based PSI technique is employed to remove atmospheric phase screen and external DEM (SRTM) is introduced to cancel topographic term. Secondly, sparse tomography is developed according to the framework of iteratively reweighted L1-norm minimization. Interestingly, unwelcome artifacts most likely due to loose RIPless dictionary and noisy disturbance are mitigated by only few iterations. Finally, to correctly identify the number of persistent scatterers in one resolution, sequential generalized likelihood ratio test with cancellation strategy is employed for post-detection. Fig. 1 demonstrates that double scatterers (brighter scatterers) interfering in one pixel are successfully separated using the integrated space-time-temperature phase model. The thermal map of Harbourfront Horizon hotel in Hong Kong is shown in Fig. 2. It can be generally concluded that motion derived from average thermal change is linearly dependent on height since the top of building accumulates vertical motion of construction materials at each elevation.

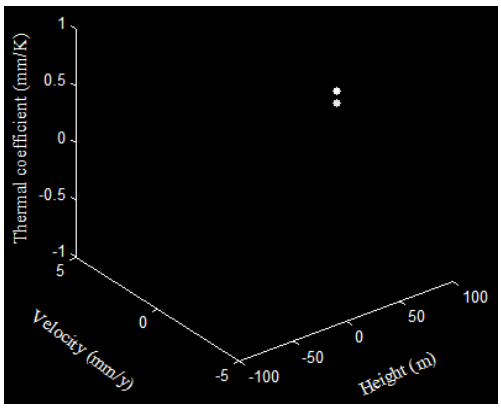

Fig.1. 5-D SAR by CS

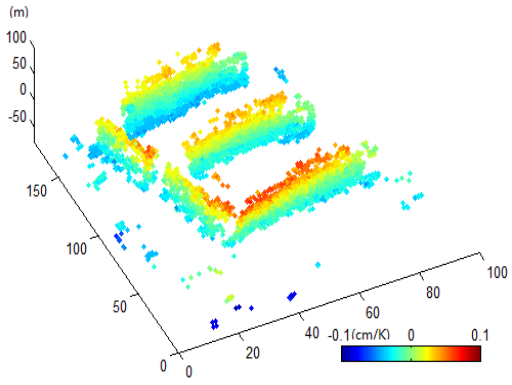

Fig. 2. Thermal map of Harbourfront Horizon hotel by CS

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